U.S. DEPARTMENT OF COMMERCE PATENT & TRADEMARK OFFICE

B/O Form PTO-1390	**Transmittal Letter to the United States Designated/Elected Office (DO/EO/US) Concerning a Filing Under *35 USC 371***	*Attorney's Docket Number* BALD3006/JEK
		U S Application Number (if known) 10/070444
International Application Number PCT/EP00/09131	*International Filing Date* 18 September 2000	*Priority Date Claimed* 20 September 1999
Title of Invention METHOD FOR PROTECTING A PROGRAM FLOW		
Applicant(s) for DO/EO/US Michael BALDISCHWEILER	Assignee	

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items under *35 USC 371*:

1. ☒ This is a **FIRST** submission of items concerning a filing under *35 USC 371*.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under *35 USC 371*.

3. ☒ This express request to begin national examination procedures *(35 USC 371(f))* at any time rather than delay examination until the expiration of the applicable time limit set in *35 USC 371(b)* and PCT Articles 22 and 39(1).

4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. ☒ A copy of the International Application as filed *35 USC 371(c)(2)*.
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).

6. ☒ A translation of the International Application into English *(35 USC 371(c)(2))*.

7. ☒ Amendments to the claims of the International Application under PCT Article 19 *(35 USC 371(c)(3))*
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.

8. ☐ A translation of the amendments to the claims under PCT Article 19 *(35 USC 371(c)(3))*.

9. ☒ An oath or declaration of the inventor(s) *(35 USC 371(c)(4))*. (☐ Executed   ☒ Unexecuted)

10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 *(35 USC 371(c)(5))*.

Items 11 to 16 below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under *37 CFR 1.97* and *1.98*.

12. ☐ An assignment document for recording. A separate cover sheet in compliance with *37 CFR 3.28* and *3.31* is included.

13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.

14. ☐ A substitute specification.

15. ☐ A change of power of attorney and/or address letter.

16. ☐ Other items or information:

Application Number (if Known)	International Application Number	Attorney's Docket Number	
10/070444	**PCT/EP00/09131**	**BALD3006/JEK**	
		Calculations	PTO USE ONLY

17. The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

☒ Search report has been prepared by the EPO or JPO $890.00

☐ International Preliminary Examination Fee paid to USPTO (37 CFR 1.482) $710.00

☐ No International Preliminary Examination Fee paid (37 CFR 1.482)
   but International Search Fee paid to USPTO (37 CFR 1.445(a)(2)) $740.00

☐ Neither International Preliminary Examination Fee (37 CFR 1.482) nor
   International Search Fee (37 CFR 1.445(a)(2)) paid to USPTO $1040.00

☐ International Preliminary Examination Fee paid to USPTO (37 CFR 1.482)
   and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00

ENTER APPROPRIATE BASIC FEE AMOUNT	$	890.00	

Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE			
Total Claims	5	-20 =	0	× $18.00	$	0.00	
Independent Claims	1	-3 =	0	× $84.00	$	0.00	
Multiple Dependent Claims (if applicable)				+ $280.00			

TOTAL OF ABOVE CALCULATIONS	$	890.00	

Reduction by ½ for filing by small entity, if applicable. Small Entity Status is asserted pursuant to 37 CFR 1.27 for this application.

SUBTOTAL	$	890.00	

Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

TOTAL NATIONAL FEE		$	

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31).   **$40.00** per property.

TOTAL FEES ENCLOSED	$	890.00	

Amount to be:	Refunded:	
	Charged:	

a. ☒ A check in the amount of **$890.00** to cover the fees is enclosed.

b. ☐ Please charge my **Deposit Account Number 02-0200** in the amount of **$** to cover the above fees.
   A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to **Deposit Account Number 02-0200**. A duplicate copy of this sheet is enclosed.

Note: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Customer 23364

BACON & THOMAS, PLLC
625 SLATERS LANE - FOURTH FLOOR
ALEXANDRIA, VIRGINIA 223124-1176
(703) 683-0500

DATE: 20 March 2002

Respectfully submitted,

J. Ernest Kenney
Attorney for Applicant
Registration Number: 19,179

<div align="right">**PATENT**</div>

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

International Patent Application
No. PCT/EP00/09131

<div align="right">**PCT/DO/EO/US**</div>

International Filing Date: 18 September 2000

<div align="right">**Attorney Docket: BALD3006/JEK**</div>

Applicant: Michael BALDISCHWEILER

For: METHOD FOR PROTECTING A PROGRAM FLOW

<div align="center">**PRELIMINARY AMENDMENT**</div>

Commissioner for Patents
Washington, D.C. 20231

Sir:

This paper accompanies documents submitted to establish the U.S. national stage of the above-identified international patent application.

The international patent application was amended under PCT Article 34 and the claims as-amended in the English language are annexed to the International Preliminary Examination Report (IPER).
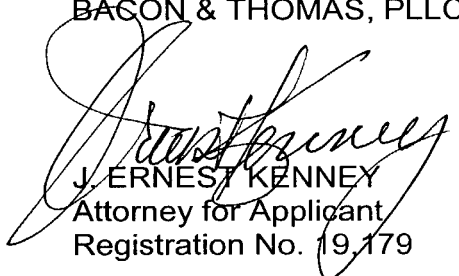

IN THE CLAIMS:

Please amend the translated claims as annexed to the IPER as shown on the appended APPENDIX OF CLAIMS, which includes amended and non-amended claims. Also appended hereto an APPENDIX OF MARKED UP CLAIMS showing the changes which have been made.

International Application No. PCT/EP00/09131
Attorney Docket: BALD3006/JEK

REMARKS

All rights are reserved to the original claimed subject matter. The claims have been amended to reduce the filing fees and to restate the inventive subject matter in clear terms. None of the amendments are intended to narrow any element of the claims as they stood prior to amendment. Examination of the application as amended is respectfully requested.

Respectfully submitted,
BACON & THOMAS, PLLC

J. ERNEST KENNEY
Attorney for Applicant
Registration No. 19,179

Customer 23364

BACON & THOMAS, PLLC

625 Slaters Lane - 4th Floor
Alexandria, VA 22314-1176
Telephone: (703) 683-0500
Facsimile: (703) 683-1080

Date: March 20, 2002

S:\Producer\jek\BALDISCHWEILER - BALD3006\preliminary amendment.wpd

International Application No. PCT/EP00/09131
Attorney Docket: BALD3006/JEK

APPENDIX OF CLAIMS

1. A method for protecting the program run at the call of subprograms, the called program performing, before or during the program execution, a check of the data passed directly or indirectly from the calling program, characterized in that

- the calling program forms a first check sum for the parameters to be passed (step 2),

- said first check sum is stored in a specially provided memory area,

- the called program forms, before its execution, a second check sum for the received parameters (step 5) and checks it for equality with the first check sum (step 6), and

- in case of inequality of the first and second check sums the program is terminated (step 7) or an error message outputted.

2. A method for protecting the program run at the call of subprograms, the called program performing, before or during the program execution, a check of the data passed directly or indirectly from the calling program, characterized in that upon call of a subprogram a timer is started (step 22) which counts the number of clock cycles required for executing the program and terminates the program if the preset number of clock cycles was exceeded before termination of the subprogram (step 26).

3. A method according to claim 1, characterized in that the memory area for storing the check sum is a RAM or register area.

4(Amended). A method according to claim 1, characterized in that the return addresses of the calling function are entered in a table and the called program checks the return address reported by the calling program (step 13) by checking the presence of said return address on the basis of the table.

-1-

International Application No. PCT/EP00/09131
Attorney Docket: BALD3006/JEK

5(Amended). A method according to claim 2, characterized in that the timer value is read at certain preset points (step 24) and compared with a likewise preset intermediate value (step 25) and the program is terminated if the preset intermediate value was exceeded (step 26).

S:\Producer\jek\BALDISCHWEILER - BALD3006\appendix of claims wpd

International Application No. PCT/EP00/09131
Attorney Docket: BALD3006/JEK

APPENDIX OF MARKED UP VERSION OF CLAIMS

1. A method for protecting the program run at the call of subprograms, the called program performing, before or during the program execution, a check of the data passed directly or indirectly from the calling program, characterized in that

    - the calling program forms a first check sum for the parameters to be passed (step 2),

    - said first check sum is stored in a specially provided memory area,

    - the called program forms, before its execution, a second check sum for the received parameters (step 5) and checks it for equality with the first check sum (step 6), and

    - in case of inequality of the first and second check sums the program is terminated (step 7) or an error message outputted.

2. A method for protecting the program run at the call of subprograms, the called program performing, before or during the program execution, a check of the data passed directly or indirectly from the calling program, characterized in that upon call of a subprogram a timer is started (step 22) which counts the number of clock cycles required for executing the program and terminates the program if the preset number of clock cycles was exceeded before termination of the subprogram (step 26).

3. A method according to claim 1, characterized in that the memory area for storing the check sum is a RAM or register area.

4(Amended). A method according to [any of claims 1 to 3] claim 1, characterized in that the return addresses of the calling function are entered in a table and the called program checks the return address reported by the calling program (step 13) by checking the presence of said return address on the basis of the table.

-1-

5(Amended). A method according to claim 2 [or 4], characterized in that the timer value is read at certain preset points (step 24) and compared with a likewise preset intermediate value (step 25) and the program is terminated if the preset intermediate value was exceeded (step 26).

S:\Producer\jek\BALDISCHWEILER - BALD3006\appendix of marked up version of claims wpd

(54) Title: METHOD FOR PROTECTING A PROGRAM FLOW

(54) Bezeichnung: VERFAHREN ZUR SICHERUNG EINES PROGRAMMABLAUFS

1...PARAMETER
2...CHECKSUM 1
3...CALL SUB-PROGRAMME
4...RUN SUB-PROGRAMME
5...CHECKSUM 2
7...END PROGRAMME
8...EXECUTE PROGRAMME
JA...YES
NEIN...NO
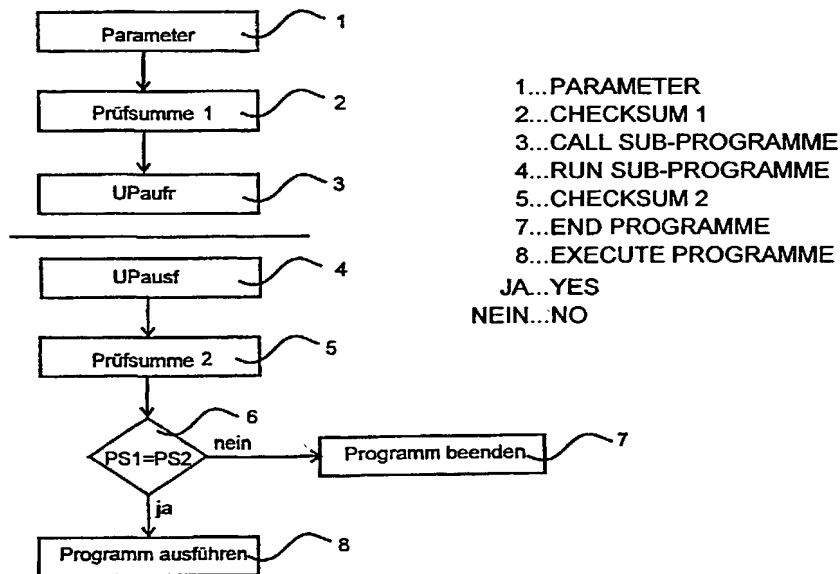
(57) Abstract: The invention relates to a method for protecting the program flow during sub-program calls. Known methods for protecting data contract the evaluation of data by specific interruption of the program, do not however offer any effective protection for modular programs, especially with regard to sub-program calls. According to the invention, the requested program therefor checks the data communicated directly or indirectly by the requesting program before or during the execution of the program.

[Fortsetzung auf der nächsten Seite]

Method for protecting a program run

The present invention relates to a method for protecting the program run according to claim 1.

In particular with security-relevant applications, for example in the area of IC cards, it is necessary to protect the program run from unauthorized manipulation. For protecting secret data, for example secret key data, it is known to store the data to be protected in encrypted form in order to prevent readout by unauthorized persons.

Access to secret data can also be effected, however, by selectively interrupting the program run resulting in errors in the encryption routines from which the secret data can be inferred after repeated selective interruption.

To avoid such attacks it is necessary to reliably recognize errors or disturbances of the program run. German patent DE 37 09 524 C2 discloses a method for checking the memory cell contents of a program memory in a computer. Therein, several check sums are stored which are formed from memory cell contents of different address and data memory areas. The check sums are determined at the onset of and/or during computer operation and compared with the stored check sum. Upon ascertainment of a deviation an error signal is outputted.

The method known from DE 37 09 524 C2 is suitable mainly for checking the correctness of data used in a program. It disregards the fact that manipulation of the program run can be effected also or in particular upon program calls, i.e. upon execution of sub- or function programs.

It is therefore the problem of the present invention to state a method allowing a reliable check of modularly constructed programs, in particular upon subprogram calls.

This problem is solved according to the invention by the called program performing a data check which ascertains reliable transfer of the data to be passed from the calling program.

The invention achieves additional security which guarantees not merely that individual program parts are executed reliably and completely but that the total program run is undisturbed and free from manipulation.

An advantageous embodiment of the invention provides that the calling program first forms a check sum for the parameters passed from the calling program to the

called program, said check sum being stored in a specially provided memory area. After the parameters are passed the called program also forms a check sum for the received parameters. If the check sums formed by the calling and called programs are different, the program is terminated.

In this way it can be ensured that a function program, in particular a function program executing security-relevant data, is already examined for manipulation at the onset, so that the start of the called program with faulty parameters can be prevented from the start and no evaluation of the erroneous data is permitted.

The memory area provided for storing the check sum is preferably created in a RAM or register area.

A further or alternative embodiment for forming the check sum for the parameters to be passed results from the check of the return addresses. The return addresses of the calling functions are entered in a table and the called program can check by means of said table whether the return address transmitted by the calling program is present in the table. In case of a faultily reported return address, the program can be interrupted.

A further alternative or additional security check can be effected by starting a timer upon call of a subprogram or function program. Said timer counts the clock cycles necessary for executing the program. The number of clock cycles required for the regular subprogram run is first preset as the limiting value for the timer. The program is terminated if the number of preset clock cycles was exceeded before the end of the subprogram.

The timer value is advantageously also read at certain preset points of the subprogram and compared with likewise preset intermediate values. In this case as well, the program is terminated if the preset intermediate value was exceeded.

In the following, the invention will be explained in more detail with reference to Figs. 1 to 3, in which:

Figure 1 shows a flowchart for the check by means of check sum,

Figure 2 shows the flow for the check by means of return address table,

Figure 3 shows the flow for the check by means of timer.

Figure 1 describes the run of a subprogram call, in particular a function call, function steps 1 to 3 relating to the program to be called and function steps 4 to 8 relating to the evaluation of the subprogram.

In the program to be called the parameters necessary for executing the subprogram are first provided in step 1. For said parameters a check sum is formed in step 2, consisting in the simplest case of a parity check. Common methods for check sum formation, e.g. CRC (cyclical redundancy check) or EDC, can of course also be employed. The thus determined check sum is written to a specially provided memory area. Said memory area may be a volatile memory (RAM) or a nonvolatile, rewritable memory (e.g. EEPROM).

Subsequent to the formation and storage of check sum 1 the subprogram call takes place in step 3. Step 4 is the onset of execution of the subprogram. In said subprogram, check sum 2 is first formed for the passed parameters. Said check sum is formed by the same method used for determining check sum 1 in the calling program.

Next, a check of check sums PS1 and PS2 for equality is effected in step 6. If it is ascertained in step 6 that the two check sums are unequal, it can be assumed that an error has occurred in the passing of the program parameters, which may be an indication of an intended disturbance aimed at determining secret data. As a measure, the program can be ended in step 7 or corresponding alternative measures are taken, for example an error message to the main program.

If it is ascertained in step 6 that that check sums PS1 and PS2 are equal, the actual function execution is begun.

Figure 2 shows a possibility of program protection by checking the return addresses. Return addresses are stacked by hardware at the function call. In the present case the information is thus likewise passed from the calling program (e.g. return addresses) to the subprogram in step 11 at the subprogram call. According to the invention, the return addresses are managed in table 17 and upon execution of the subprogram the return addresses - insofar as they are stored in RAM - are first examined for consistency in step 12, to be checked on the basis of table 17 in step 13. If it was ascertained in step 14 that the passed return address is not present in the table, the program is ended with step 15. Otherwise the execution of the function program is begun in step 16.

Figure 3 shows an embodiment in which the correct program run or the undisturbed program run is checked by means of a timer. Directly after the start of the subprogram in step 21 a timer is started in step 22. Said timer is designed to measure the time or count the clock cycles required for executing the subprogram. Subsequent to the start of the timer in step 22, the function of the subprogram is executed with step 23 and the timer is stopped in step 24 after the end of the function. In step 25 it is checked whether the number of clock cycles required for executing the function program matches the preset number of clock cycles. If there is no match, the program is ended with step 26. Otherwise the program execution is continued in step 27, for example by jumping back to the main program.

Figure 3 shows that the timer is stopped and checked after the run of the function or function program. In practice, security can be increased by providing certain points in the function program where the timer is additionally checked. This might prevent the function program from being largely executed despite an error or attack.

Alternatively it can also be provided that the timer value is compared continuously with a limiting value after the start and the program terminated if said limiting value has been reached or exceeded.

The individual examples according to Figures 1 to 3 have been shown as independent, alternative measures. Security can be increased by combining the examples. The greatest security is obtained by parallel checks by check sum, return address and timer.

Claims

1. A method for protecting the program run at the call of subprograms, the called program performing, before or during the program execution, a check of the data passed directly or indirectly from the calling program, characterized in that
   - the calling program forms a first check sum for the parameters to be passed,
   - said first check sum is stored in a specially provided memory area,
   - the called program forms, before its execution, a second check sum for the received parameters and checks it for equality with the first check sum, and
   - in case of inequality of the first and second check sums the program is terminated or an error message outputted.

2. A method for protecting the program run at the call of subprograms, the called program performing, before or during the program execution, a check of the data passed directly or indirectly from the calling program, characterized in that upon call of a subprogram a timer is started which counts the number of clock cycles required for executing the program and terminates the program if the preset number of clock cycles was exceeded before termination of the subprogram.

3. A method according to claim 1, characterized in that the memory area for storing the check sum is a RAM or register area.

4. A method according to any of claims 1 to 3, characterized in that the return addresses of the calling function are entered in a table and the called program checks the return address reported by the calling program by checking the presence of said return address on the basis of the table.

5. A method according to any of claims 2 to 4, characterized in that the timer value is read at certain preset points and compared with a likewise preset intermediate value and the program is terminated if the preset intermediate value was exceeded.

Abstract

The invention relates to a method for protecting the program run at the call of subprograms. Known data protection methods counteract an evaluation of data by selective program interruption, but offer no effective protection for modularly constructed programs, in particular at the call of subprograms. According to the invention, the called program therefore performs, before or during the program execution, a check of the data passed directly or indirectly from the calling program.
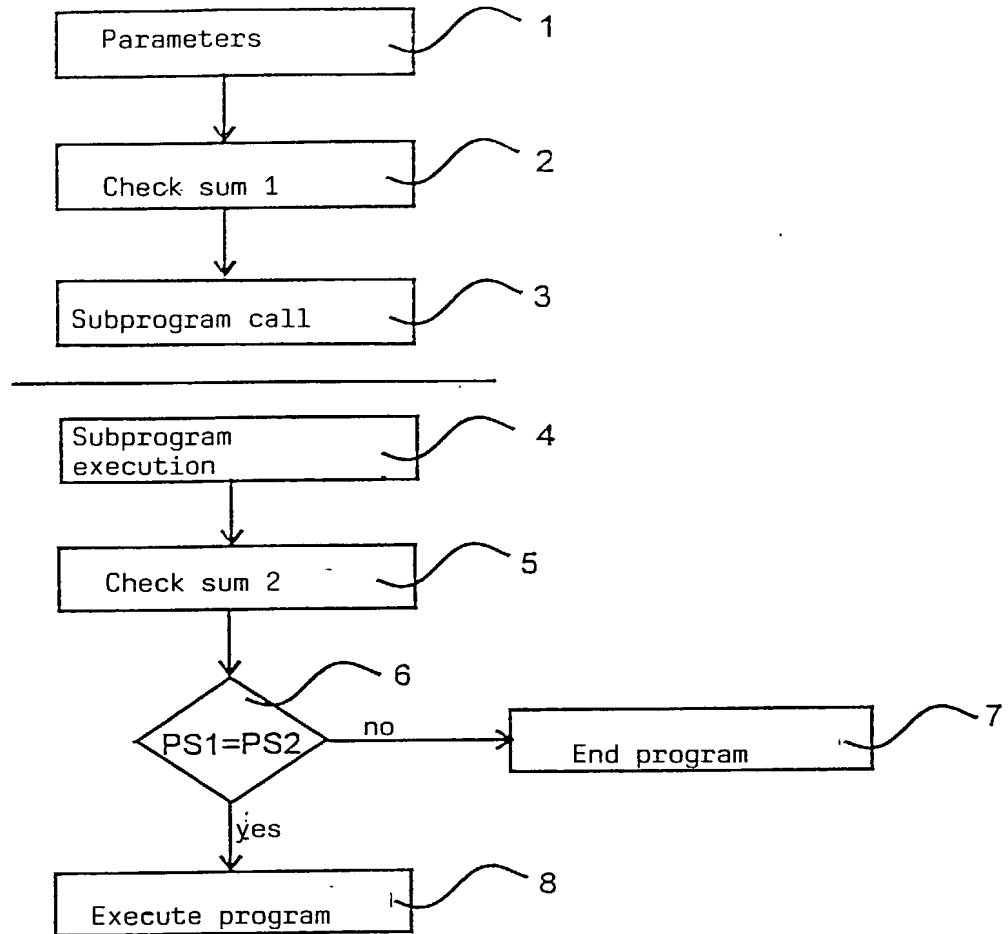
Fig. 1

```
┌─────────────────┐
│   Parameters    │ ～ 1
└─────────────────┘
         │
         ▼
┌─────────────────┐
│  Check sum 1    │ ～ 2
└─────────────────┘
         │
         ▼
┌─────────────────┐
│ Subprogram call │ ～ 3
└─────────────────┘
─────────────────────

┌─────────────────┐
│   Subprogram    │ ～ 4
│   execution     │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│  Check sum 2    │ ～ 5
└─────────────────┘
         │
         ▼
        / \
      /     \  ～ 6          no   ┌──────────────┐
     ( PS1=PS2 )──────────────────▶│ End program  │ ～ 7
      \     /                      └──────────────┘
        \ /
         │ yes
         ▼
┌─────────────────┐
│ Execute program │ ～ 8
└─────────────────┘
```

Fig. 1

Fig. 2

```
┌─────────────────┐
│ Subprogram call │ ～ 11
└─────────────────┘
         │
         ▼
─────────────────────

┌──────┐        ┌─────────────────────┐
│      │        │ Load return address │ ～ 12
│      │        └─────────────────────┘
│      │                 │
│  ～17│                 ▼
│   ·  │        ┌─────────────────────┐
│   ·  │        │ Check return address│ ～ 13
│   ·  │        └─────────────────────┘
│      │                 │
│      │                 ▼
│      │                / \
└──────┘              /     \ ～ 14       no   ┌──────────────┐
                     ( RAdr o.k.? )─────────────▶│ End program  │ ～ 15
                      \     /                    └──────────────┘
                        \ /
                         │ yes
                         ▼
                ┌─────────────────┐
                │ Execute program │ ～ 16
                └─────────────────┘
```
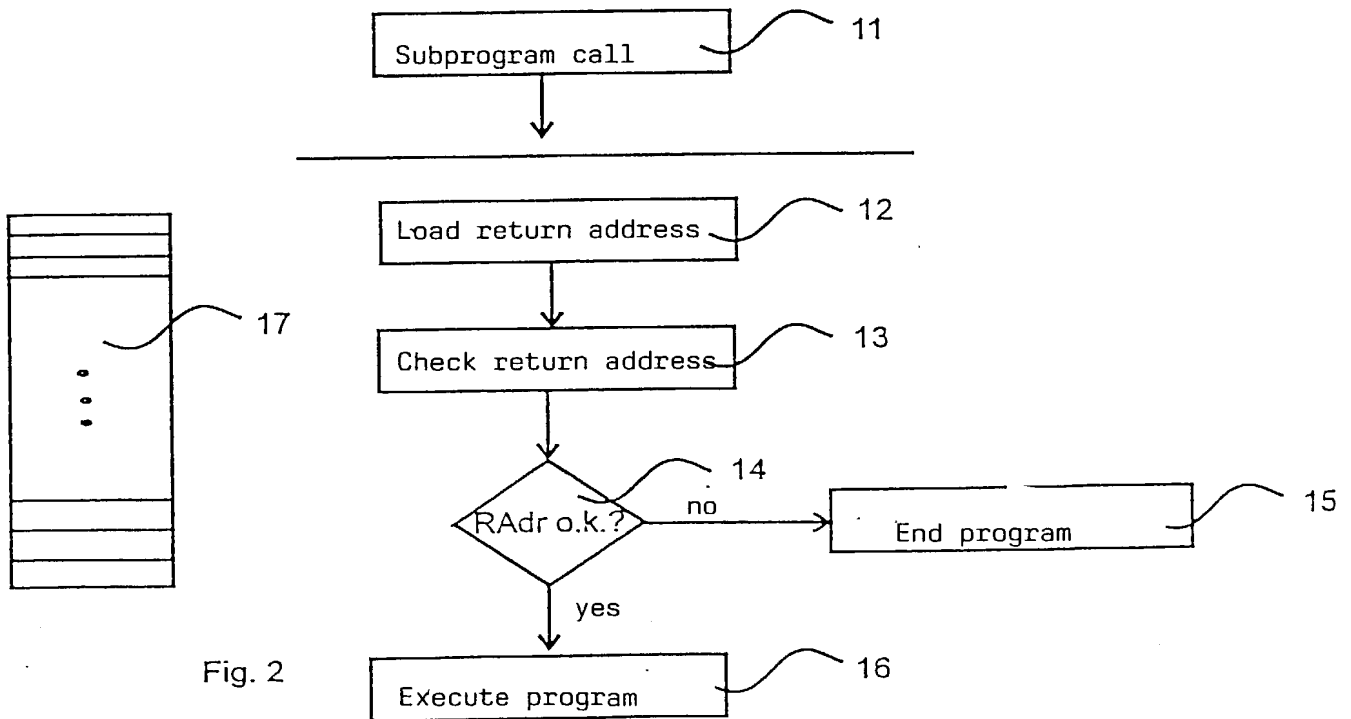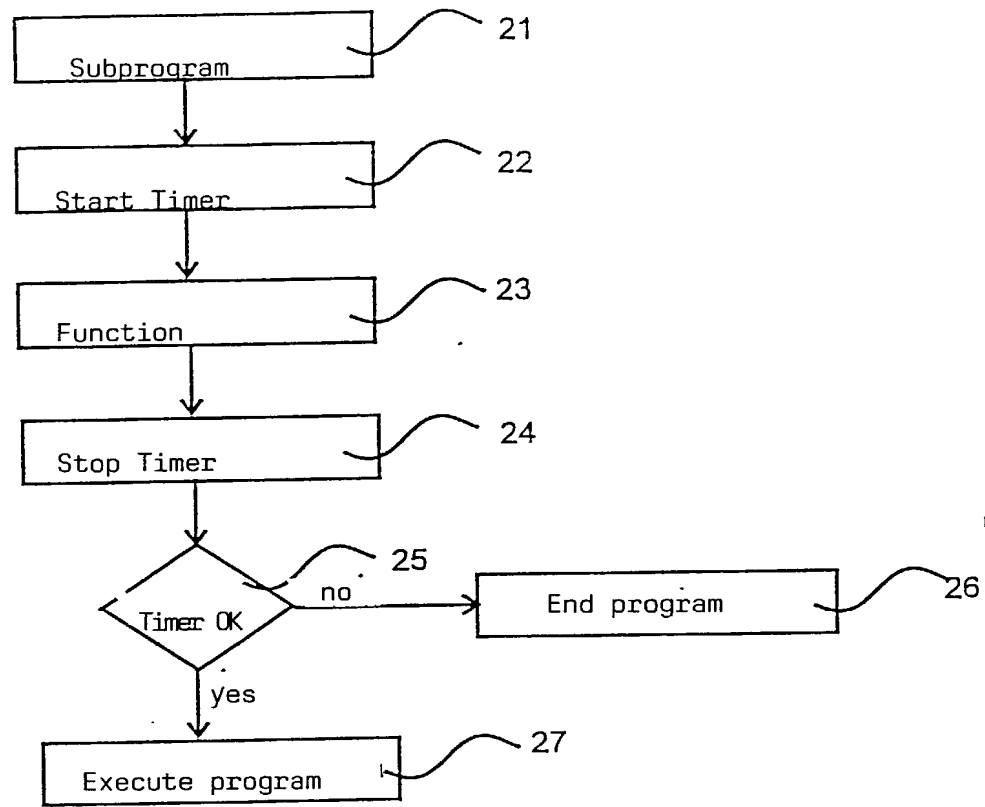
Fig. 2

Fig. 3

DECLARATION FOR PATENT APPLICATION AND APPOINTMENT OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention (Design, if applicable) entitled:

METHOD OF PROTECTING A PROGRAM FLOW

the specification of which (check one):

☐ is attached hereto, or ☒ was filed on· **18 September 2000** as PCT International Application Number: **(PCT/EP00/09131)**

10/070,444 and (if applicable) was amended on: 26 November 2001

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in *Title 37, Code of Federal Regulations, §1 56.* I hereby claim foreign priority benefits under *Title 35, United States Code §119* of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN APPLICATION(S)			PRIORITY CLAIMED	
Number	Country	Day/Month/Year Filed	Yes	No
199 44 991.0	Germany	20 September 1999	X	

☐ Additional Priority Application(s) Listed on Following Page(s)

I HEREBY CLAIM THE BENEFIT UNDER TITLE 35 U.S. CODE §119(E) OF ANY U.S. PROVISIONAL APPLICATIONS LISTED BELOW.	
Application Number	Day/Month/Year Filed

☐ Additional Provisional Application(s) Listed on Following Page(s)

I hereby claim the benefit under *Title 35, United States Code, §120* of any United States application(s) or PCT international application(s) designating The United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of *Title 35, United States Code, §112,* I acknowledge the duty to disclose information which is material to patentability as defined in *Title 37, Code of Federal Regulations, §1 56* which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application:

Application Number	Filing Date	Status - Patented, Pending or Abandoned

☐ Additional US/PCT Priority Application(s) listed on Following Page(s)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under *section 1001 of title 18 of the United States Code* and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: I (We) hereby appoint as my (our) attorneys, with full powers of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: J. Ernest Kenney, Reg. No. 19,179; Eugene Mar, Reg. No. 25,893; Richard E. Fichter, Reg. No. 26,382; Thomas J. Moore, Reg. No. 28,974; Joseph DeBenedictis, Reg. No. 28,502; Benjamin E. Urcia, Reg. No. 33,805; and

I(we) authorize my(our) attorneys to accept and follow instructions from **Klunker, Schmitt-Nilson, Hirsch** regarding any matter related to the preparation, examination, grant and maintenance of this application, any continuation, continuation-in-part or divisional based thereon, and any patent resulting therefrom, until I(we) or my(our) assigns withdraw this authorization in writing.

Send correspondence to: | Customer 23364 | BACON & THOMAS, PLLC
625 Slaters Lane - 4th Floor
Alexandria, VA 22314-1176

Telephone Calls to: **J. Ernest Kenney**
(703) 683-0500

FULL NAME OF FIRST OR SOLE INVENTOR	CITIZENSHIP
Michael BALDISCHWEILER	**Germany**
RESIDENCE ADDRESS Hansjakobstrasse 99, 81825 Munchen Germany	POST OFFICE ADDRESS IS THE SAME AS RESIDENCE ADDRESS UNLESS OTHERWISE SHOWN BELOW
DATE X *18.04.02*	SIGNATURE X *Michael Baldischweiler*

☐ *See following page(s) for additional joint inventors.*